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A Proposal to Study Soil Nutrient Losses Resulting From Clear Cutting the Aspen Forest Type

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Background: Aspen in the Lake States.

Aspen forests are a major resource of the northern Lake States (Graham, et al., 1963). They provide man with a good quality wood fiber, and as such aspens are commercially the most important pulpwood species in northern Michigan, Wisconsin and Minnesota. Aspen forests are clearcut on a large scale for both pulpwood harvests and for game management purposes. Regrowth of young aspen is rapid and the young sprouts provide browse for deer and cover for smaller game animals and birds. Aspen forests are also aesthetically important on the landscape, providing variety in forest structure and beauty in all seasons with their unusual habits of bark and foliage coloration.

Aspen stands are transient in a natural landscape, composed of short lived individuals incapable of regenerating themselves by seeding. Without natural disturbances or interference by man, aspen is naturally replaced by the more competitive and long lived tree species of the northern conifer and hardwood forests. Traditionally man has maintained aspen stands by clear cutting both for economic and silvicultural reasons (U.S.D.A., 1965). Aspen forests regenerate by sprouting from roots of cut trees, and in fact new sprouts will not develop until the stems of older trees are cut or seriously injured.

The aspen forests of the northern Great Lakes region today originated as sprout stands following the early logging and subsequent uncontrolled fires between 1870 and 1920 (Graham, et al., 1963). Younger stands have been established over the past several decades by the practice of clear cutting the older (50 to 80 yr. old) aspen forests. Clear cutting of aspen is becoming a more accepted practice each year, especially with pressures from man for more timber and game. Yet today we have no good evidence of the consequences of such practice on the environments of soil and water in the Great Lakes region.

Forest Clearcutting and Nutrient Losses

The practice of clear cutting forests is being brought under strong criticism throughout the U.S. today (Connaughton, 1970, Davis, 1971; Brooks, 1971). Re-evaluation of economic and silvicultural motives are being made in consideration of possible aesthetic and environmental degradations resulting from the clear cutting of forests. Much of the current criticism is a consequence of a study of vegetation removal in New Hampshire, in which it was found that soil nutrient losses were alarmingly accelerated from a watershed denuded of a northern hardwood forest (Likens, et al., 1970). Losses of several nutrient cations were increased more than 10 fold over uncut forest, and nitrate losses were increased over 50 fold as a result of forest removal. Downstream aquatic ecosystems were seriously enriched by runoff waters from this cleared watershed.

Work approved. Zahner, Univ. of Mich., has commenced this research. Field work being done on Univ. Biol. Sta. in lower Mich. WDB 11/20/70

It is not known whether similar soil nutrient leaching accompanies clear cutting of aspen forests in the Lake States. In the New Hampshire study cation losses were attributed to a series of events resulting from vegetation removal: a natural forest recycles mineralized ammonium ions and maintains a low level of nitrification; with vegetation removal, nitrogen uptakes ceases and ammonium is available for production of nitrates, which process releases large amounts of hydrogen ions that in turn accelerate cation exchange with soil colloids; thus both cations and nitrates are leached from the ecosystem by percolating rainwaters.

It is theorized that these processes will not occur to any serious extent under clearcut aspen because of the immediate revegetation by aspen root sprouts. The mature root systems of harvested aspen trees remain alive and fully occupy the soil following clear cutting. Within one year the site may support a sprout stand that numbers from 10,000 to 200,000 per acre. This rapid development of shoots should permit the absorption and recycling of nutrients from the soil solution and prevent their loss from the site. There are, however, no scientific data to substantiate this aspect of aspen clear cutting nor are there any published studies of nutrient cycling in aspen forest ecosystems.

Other criticisms of commercial forest clear cutting in the U.S., as increased surface runoff, soil erosion, and decreased slope stability, may not apply to clear cutting aspen forests in the northern Lake States. Aspen stands here reach their best development on sand and sandy loam and clay soils. Because infiltration capacity of sandy soil is extremely high, there have been no reports of increased erosion related to forest clear cutting in aspen.

Proposed Clearcutting Study

The forest lands of the University of Michigan Biological Station include over 4,000 acres of the aspen type, the uplands consisting mainly of Populus grandidentata and the lowlands P. tremuloides and P. balsamifera. These aspen forests have been studied intensively over the past 40 years by researchers at the Biological Station and much is known about their ecology, structure, growth habits, physiology, and soil-water relations (Gates, 1930; Farmer, 1963; Benninghoff and Cramer, 1963; Debyle, 1964; Garrett and Zahner, 1964; Zahner and DeByle, 1964; Zahner and Crawford, 1965; Barnes, 1966).

The Biological Station aspen stands are well developed, quite typical of mature (40-70 year old) aspen forests, and they occupy a full range of soil and topographic types. Most of these stands occur on well drained upland sandy soils derived of glacial outwash typical of millions of acres of the aspen type in the northern Great Lakes region. They present an excellent opportunity to study nutrient cycling and movement of nutrients through parent materials into groundwater. Through a comparison of groundwater enrichment from clearcut and undisturbed aspen stands, we can better evaluate the consequences of such practice on other ecosystems removed from clearcut areas, since these groundwaters flow directly into local streams and lakes.

We propose to study mineral cycling, nutrient losses, and biomass recovery and stability in small areas of clear cut aspen forests. These clear cuts will each be paired with an uncut natural check area of similar soil, topography, and stand structure and composition. The size of each clear cut and check area will range from perhaps 10 to 40 acres, depending on specific site and stand factors. We propose two or three replications of pairs of cut and check areas.

The vegetation and soils of each study area will be inventoried and calibrated for one growing season prior to clear cutting, to establish base relations between each check area and its respective clearcut area. Each area will be sampled for standing biomass, nutrient content of vegetation, of litter, of soil organic matter, and of precipitation of the soil solution, and of water percolating to groundwater. Methodology for these various measurements are well established and with minor modification can be readily applied to this study. Much of the laboratory instrumentation and equipment will have to be purchased specifically for this project, however, as they are not on hand.

After a one year calibration period, that portion of each area designated for clearcutting will be so treated in the fall of the year. Vegetation will be dormant and the cutting period will be followed closely by winter conditions.

Beginning with the spring snowmelt period, nutrient contents of precipitation of the soil solution, and of water percolating to groundwater will be carefully monitored on both cut and check areas. These measurements will be continued over several years, probably in detail after each significant precipitation event for two years, and then periodically at perhaps 5 and 10 years after clear cutting. Regrowth of the aspen and other vegetation biomass will be measured closely for both quantitative rates and quality of nutrient cycling. Litter and organic matter at the soil surface and throughout the soil profile will also be analyzed periodically for nutrient content and rates of accumulation and decomposition.

Results of all of the above measurements will test the hypothesis that carefully controlled clear cutting of aspen stands in sandy soils does not result in significantly accelerated nutrient losses from the forest ecosystem, and therefore does not contribute detrimentally to accelerated nutrient enrichment of groundwaters, streams, and lakes into which subsurface runoff flows.

Statistical analysis of data from the first two years after clear cutting, comparing nutrient cycling on, and losses from, the cut and check areas, should provide the basis for accepting or rejecting the above hypothesis. The interpretation will be valid on condition that aspen regrowth be allowed to develop naturally following clear cutting, as is the accepted practice for game and timber management in the northern Great Lakes region.

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